ELM as a trigger mechanism for the transition between two edge regimes

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It is well known that there are some different regimes possible for the edge plasma in tokamak. In particular one can observe high temperature, low impurity radiation regimes as well as relatively low temperature ones with strongly radiating edge plasma. Recent experimental studies at both DIII-D and JET tokamaks show that type I-II ELMs are able to trigger irreversible transition of the edge plasma equilibrium into the colder, strongly radiating state [1].

In the present paper the theoretical model of the trigger effect is proposed. Two different stable thermal equilibria are found with equal thermal flows from the core and impurity (carbon) concentrations. The I-II ELM influence is modeled by short-term mass thermal flow rise from the core. The hydrogen density rise increases radiation losses at the edge and is able to transit the edge from high temperature regime to the low one. On the other hand the additional thermal flow produced by the ELM may prevent the transition. Simple analytical calculations as well as more advanced numerical results show ELM to be indeed capable of shifting the edge towards the lower temperature regime with strong impurity radiation, and may be even to the thermal disruption.

Fig.1 shows shift of the edge plasma equilibrium caused by the Type I ELM in JET, while fig.2 illustrates result of the numerical calculations of the similar process.

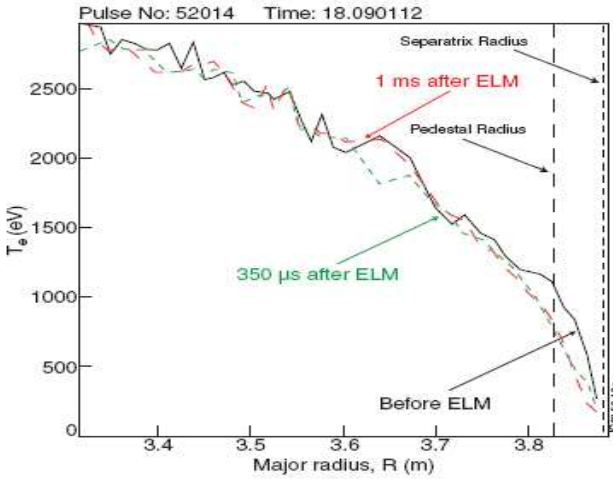

Fig.1 Electron temperature measurements in JET H-mode showing the collapse of the edge temperature caused by a 'conductive' Type I ELM in a discharge.

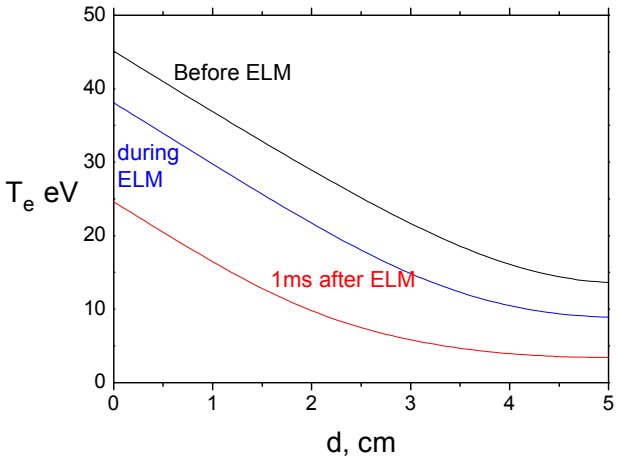

Fig.2 Electron temperature at the edge (between pedestal and separatrix) before, during (in the middle of) and 1 ms after the ELM, DIII-D parameters used.

References

[1] A Loarte, et al., Plasma Phys. Control. Fusion **45** (2003) 1549–1569